

Variable Precision Filters

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Description:

OBJECTIVE: The development of innovative mathematical techniques for the design of digital filters allowing trade-offs between accuracy, precision and memory. **DESCRIPTION:** The design of finite impulse response (FIR or non-recursive) and infinite impulse response (IIR or recursive) digital filters has a long history and, over the years, many methods have been developed to design FIR, IIR filters, adaptive filters and filter cascades. The primary task of a digital filter is to alter in some prescribed manner the frequency content of a signal. In most cases, the prescribed frequency modifications cannot be achieved exactly and, hence, filter design problems involve some type of approximation or optimization. This optimization is typically a balance between simultaneously matching the magnitude response of the filter, the phase response of the filter or the group delay of the filter with the prescribed filter specifications. These challenging optimization problems are then solved using a variety of algorithms. A critical property of a filter is its application cost, especially in problems with stringent execution time and hardware constraints. Widely used techniques for filter design define optimality of design differently and may not directly reflect the cost of filter application. For example, an algorithm that produces an optimal equiripple FIR design may not yield the most efficient (cost effective) filter for achieving given specifications. In particular, it is difficult to obtain an accurate, robust and highly efficient design for a filter that requires sharp transitions within narrow sub-bands or requires a complicated structure of the pass-band. In hardware implementations, optimization at algorithm level typically achieves greater cost reduction than at architecture or logic level. If the filter design specifications are generated via a measurement process, instead of a fixed set of specifications, one would like a design algorithm that guarantees convergence and assures accuracy and efficiency of the resulting filter. This ability to automatically design in real time such filters based

on measured data could significantly impact many applications. Desirable approaches will allow real-time, near optimal filter re-design that is then automatically deployed. The approach should lend itself to efficient hardware implementations on a variety of architectures. Because the design of optimized filters may require significant expert knowledge there is interest in new, robust approaches to automate filter design and make it possible for their use in real time applications. PHASE I: A clear description of the mathematical framework for the filter design and a demonstration of the feasibility of the proposed approach. Also the approach must be shown to perform the same or better than expert-guided techniques. In particular it must be demonstrated on filters with sharp transitions within a very narrow bandwidth as well as filters with a complicated structure of the passband. PHASE II: Successful completion of Phase II should provide a user-friendly software implementation of the proposed solutions within one or more application domains. PHASE III DUAL USE APPLICATIONS: Reduced power and weight for diverse military and civilian applications including communications and radar.